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US Army LABCOM
Atmospheric Sciences Laboratory

19 December 1990

PROCEEDINGS OF A WORKSHOP ON THE
U.S. ARMY REGIONAL AEROSOL TRANSPORT SIMULATION (ARATS)
Frimley Hall, Camberley, Surrey, England
29-30 October, 1990

EXECUTIVE SUMMARY-RECOMMENDATIONS

I. MODEL CONFIGURATION

1. The model purpose should be reflected in the model configuration as expressed by the choice of grid spacing, domain, forecast period, source description and which parameters and effects (eg soil condition, insolation) are included. The goal should be to use a configuration which is as simple as possible consistent with the nature of the problem. Added complexity should be linked to a demonstrable increase in performance or accuracy.
The model resolution and complexity should be consistent with the accuracy of the data base of measurements and observations available for model evaluation.

II. MODEL PROCESSES

2. Modeling of chemical reactions is essential when aerosol transformations are known to occur, eg photooxidant processes.

3. A precipitation module is required if deposition is to be modeled.

4. The height of the low level inversion in relation to the terrain is an important parameter in long range transport and should be included as a model parameter. Overnight subsidence inversions occur more frequently than is sometimes realized, up to [illegible]% of the time, and should be modeled. The collapse of the boundary layer at night requires that the model contain multiple vertical levels. Boundary layer venting must be considered. (This is a result of turbulence and occurred after the Chernobyl accident.)

5. Drainage flows may be more persistent than expected and should be considered for possible modeling.

6. Appropriate processes of aerosol removal (including transformation) and loss (including deposition) should be modeled.

7. Mesoscale wind fields should be modeled when frontal conditions exist. (Cold air advection in the boundary layer is associated with a narrow plume and warm air advection with a broad plume.)

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8 Cloud cover and soil moisture affect the radiation budget and may be important considerations in a given application. Cloud effects must be included when the model is applied to Europe. There may be occasions when land use effects should be incorporated in the model.

III. PARTICLE MODEL

9 Care should be exercised in applying a Lagrangian particle model where nonlinear chemical reactions may be present.

10 The presence of moisture will causes changes in particle size which may be significant. The effects on the rate of deposition must be accounted for also.

11 Baroclinic conditions can affect particle release and this should be accounted for when applicable.

IV. MODEL EVALUATION AND VALIDATION

12 Evaluation and validation procedures should reflect the purpose of the model.

13. In making the comparison between model results and observations an assessment of errors should be made, including the natural variability and fluctuations of the measured quantities.

14. A holistic approach to model design, data collection, model evaluation and model improvement should be adopted.

15 For hazard assessment it is important to define the key measure of danger. In particular to analyze the consequences of several functions of the concentration density (C) and identify the key one-is it Cmax, the integral of Cdt, the integral of C'dt or the probability of a given value of C, Pc(theta,x,t)? The relationship between toxicological impact and period of integration (1 hr, 1 min.) should be considered. Intermittency is an important factor in concentration fluctuation measurements and should be considered.

16 Note the size of the standard deviation affects the perception of error.

IV MODEL PROPERTIES

17 Sensitivity studies should be used to determine how m a given parameter must change to produce a significant char in the model result. In this way the dominant atmospheric parameters in a given scenario should be determined.

18 Both 'best case' and 'worst case' scenarios should be run to understand the full range of model behavior.

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INTRODUCTION

The development of the U. S. Army Regional Aerosol Transport Simulation (ARATS) is being undertaken at the U. S. Army Atmospheric Sciences Laboratory. The objective of the project is to assess the potential importance of long range aerosol transport on the battlefield and in peacetime military activities.

The Army relevance and payoff can be expressed as follows. The local effects of battlefield obscurants and clouds of toxic and radioactive products are well understood. However, if under certain meteorological conditions these effects may be felt at extended ranges, it is important to be able to predict when this may occur and calculate the magnitude of the effects. The payoff is the reduction in surprise and the opportunity to mitigate the effects. Similar considerations apply to the determination of long range safety hazards associated with the inadvertent release of clouds of toxic and radioactive particles.

Long range aerosol transport can result in a number of effects at receptor sites. We are interested in those which may have tactical significance for military operations, for example in the conduct of surveillance activities. To pursue this problem we are developing a methodology to determine the synoptic, local meteorologic and terrain conditions whose control of aerosol transport may lead to significant long range effects. The aerosol sources of interest include artillery dust and clouds of toxic substances. The methodology is also applicable to determining long range safety factors during chemical demilitarization operations and the long range hazard associated with the introduction of toxic biological substances into the atmosphere. Related civil problems include the calculation of long range radiation dosages from inadvertent radioactive emissions from nuclear power plants and some of the long range effects of air pollutants.

Application of ARATS to North America, Europe and the Middle East has been considered. An essential stepping stone in the development process is model evaluation and validation against suitable data bases with intercomparison against other models. The existence of the Cross Appalachian Tracer Experiment (CAPTEX) data and the Across North America Tracer Experiment (ANATEX) data along with existing studies of model performance using this data, motivates the application to North America.

The application to Europe is motivated by the existence of Army problem areas there and the possibility of model evaluation and validation using available data. Army applications in Europe include the chemical and biological hazard assessments mentioned above. The available data bases include the one assembled in consequence of the 1986 Chernobyl accident.

Because of the high level of interest in long range air pollution and radioactive particle effects in Europe, a portion of the European scientific community has become expert in the study of these effects. The purpose of the workshop was to benefit from this expertize at the outset of the ARATS project.

In the event there was an excellent response to the invitations to attend the workshop and a group broadly representative of this expertize spent two days airing the pertinent issues. The result was a series of recommendations concerning the development of ARATS which forms the Executive Summary of this report.

SUMMARY OF WORKSHOP SESSIONS

Session 1 Problem Definition and Modeling Approaches

Chair: PROFESSOR ROBERT PEARCE University of Reading

Speakers. DR HOWARD HOLT, U.S. Army Atmospheric Sciences Laboratory, WSMR, NM
ARATS project overview (see annex).

MR LOU LUCES, Physical Science Laboratory, NMSU, NM
Methodology for Modeling Extreme Effects of Aerosol Particles Transported on a Regional Scale (see annex).

DR ROBERT WALKO, Colorado State University, CO
The Regional Atmospheric Modeling System (RAMS) (see annex-paper on Regional and Mesoscale Meteorological Modeling).

DR HELEN APSIMON, Imperial College, London
Outline of Long Range Transport Modeling Work (see annex).

MR ROY MARYON, UK Meteorological Office, Bracknell
Particle Modeling using the UK Met Office Regional Meteorological Model (see annex).

Session 2 Model Evaluation Procedures

Chair: DR PAUL MASON, UK Meteorological Office, Bracknell

Speakers. DR ROGER PIELKE, Colorado State University, CO
Regional and Mesoscale Meteorological Modeling (see annex).

DR TERRY CLARK, Atmospheric Sciences Modeling Division, NOAA, Research Triangle Park, NC
Performances of Lagrangian and Eulerian Transport and Diffusion Models across Continental Scales (see annex).

Roundtable Discussion 1

Chair: DR WALTER BACH, US Army Research Office, Research Triangle Park, NC

Session 3 Mesoscale and Other Experiments and Events

Chair: PROFESSOR ROGER PIELKE, Colorado State University, CO

Speakers: DR SVEN-ERIK GRYNING, RISO Laboratory Roskilde, DK
The Oresund Experiment (see annex).

DR JOHN SWEENEY, St Patrick's College, Kildare
The Influence of Long-Range Transport of Air Pollutants on Summer Visibility at Dublin (see annex).

PROFESSOR PHILIP CHATWIN, Brunel University, Uxbridge
(now at the University of Sheffield)
Cloud-Average Concentration Statistics (see annex)

Session 4 Site Characterization and Data Bases

Chair: DR BARRY SMITH, UK Meteorological Office, Bracknell

Speakers: DR JOSEF PACYNA, Norwegian Institute for Air Research, Lillestrom, Norway
Modelling of Long-Range Transport of Trace Elements (see annex).

DR S. GERALD JENNINGS, University College, Galway
Physical Characteristics of the Ambient Aerosol at Mace Head (see annex).

DR CHRISTOPHER JONES, Chemical Defence Establishment, Porton Down, Salisbury
Concentration Fluctuation Measurements in Convective and Stable Atmospheres.

Roundtable Discussion 2.

Chair: PROFESSOR ROBERT PEARCE, University of Reading